Detonator Technology for Special Environments

EMS-PATVAG AG
CH-7013 Domat / Ems
Switzerland

Markus Joost

43rd Fuze Conference 1999, Tampa FL

Overview

- The detonator as the interface between electrical and pyrotechnic energy
- Standard requirements for a detonator
- Bridge-Wire Detonators, the proven technology
- Special requirements for detonators
- Thin-Film detonator technology as an alternative
- Bridge Wire vs. Thin film
- Key Components
- Reference projects with special requirements
- Future designs

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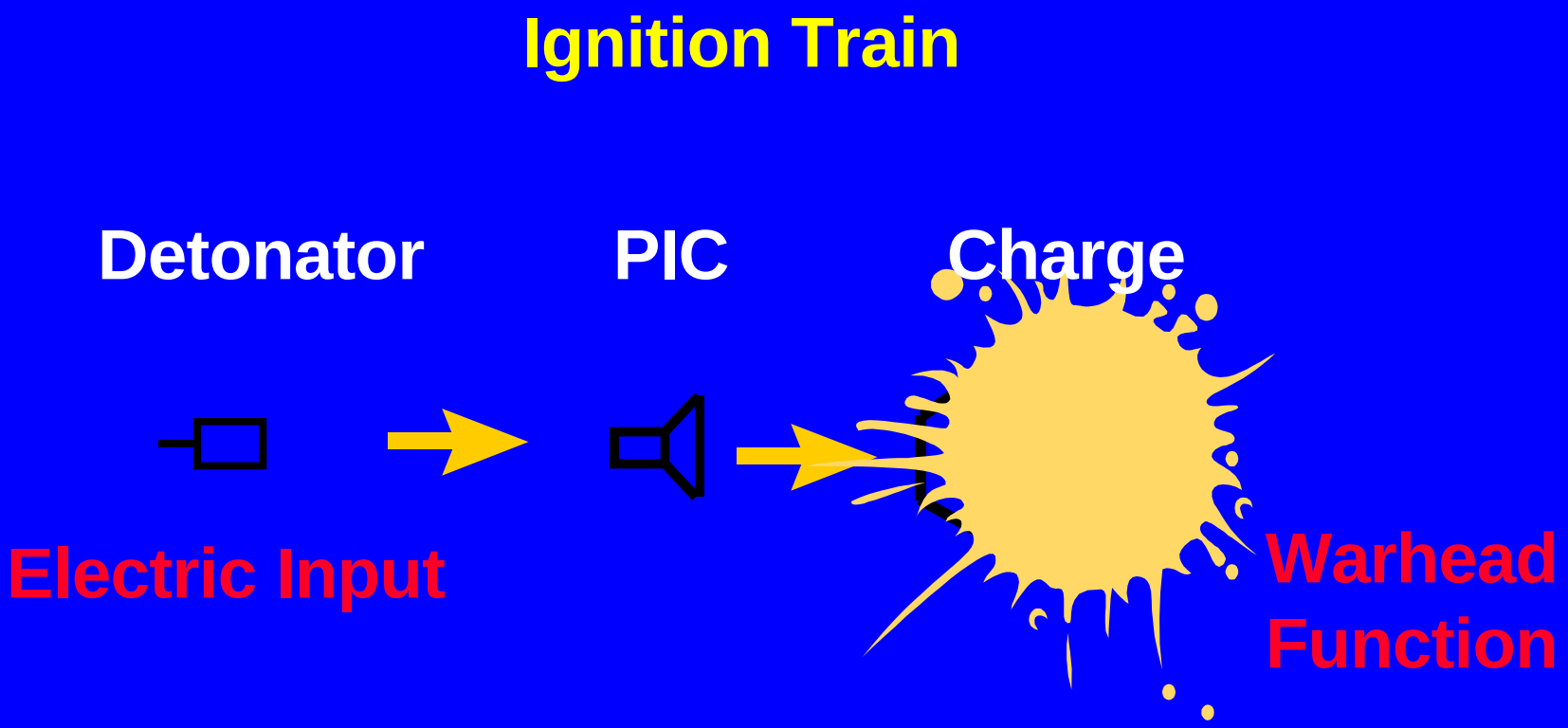
The detonator as the interface between the electric and the pyrotechnic energy



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Standard requirements for a detonator

- Correct functioning
- Small in size
- Ability to affect the environment for a safe handling
- Fast response, short delay time
- No restrictions after environmental testing
- Long life
- Low price

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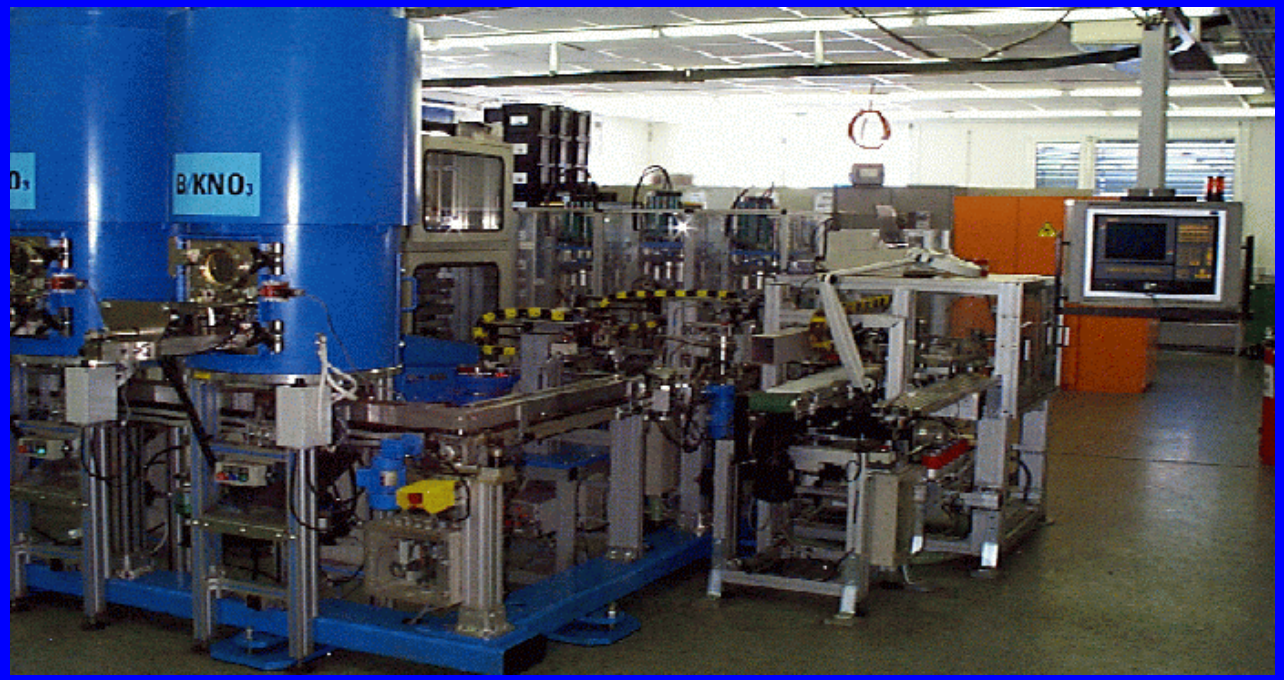
Bridge-Wire Detonators, the proven technology

- **General advantages**
  - > **Standard technology for more than 40 years**
  - > **Many different types, sizes and applications**
  - > **Low cost when produced in high numbers**



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Bridge-Wire Detonators, the proven technology

- **General disadvantages**
  - > **Critical welding process to manufacture the wire-bridge**
  - > **Limited in withstanding high acceleration and spin-rates**
  - > **Limited in a minimal firing energy**

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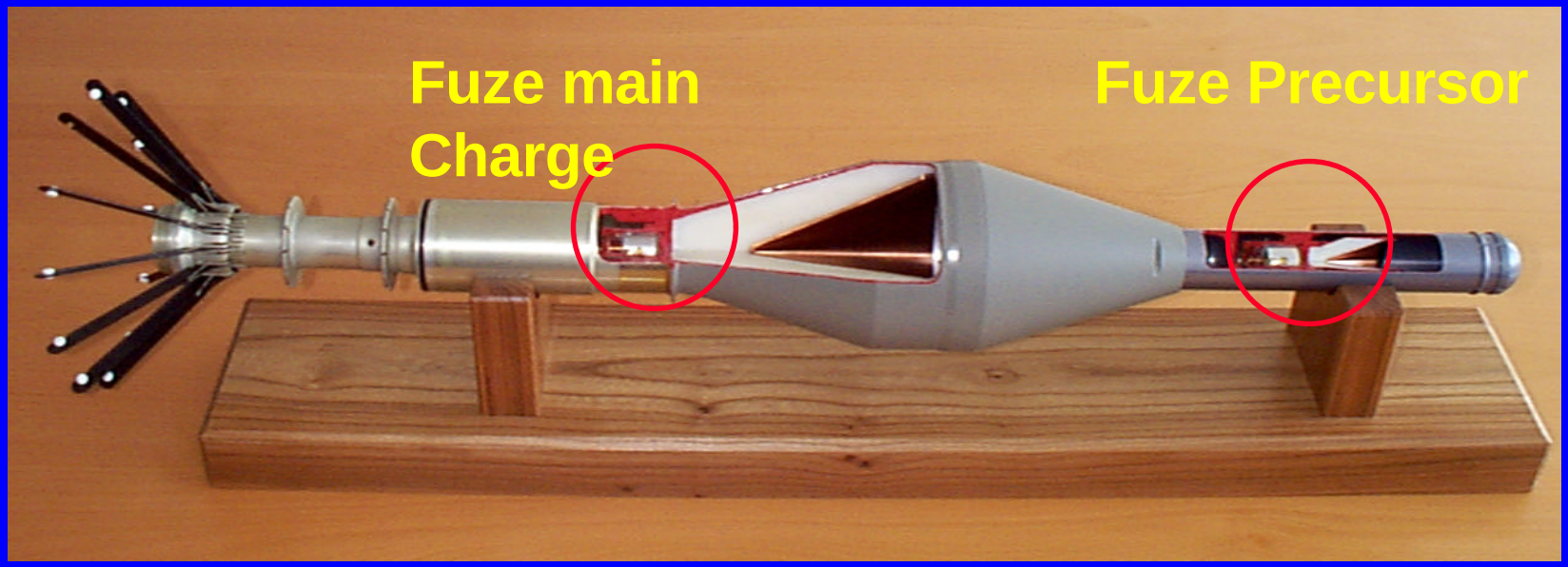
Special requirements for detonators

- Very low firing energies (<100µJ)
- Ability to withstand accelerations up to 100'000 g
- Ability to withstand spin-rates up to 120'000 rpm
- Very small in size



Example: Swiss Panzerfaust, Tandem Warhead

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Thin film technology as an alternative to meet special requirements

- Typical Firing energy of 40µJ
- Low bridge mass gives ability to withstand up to 100'000 g
- Symmetric bridge design gives ability to withstand more than 100'000 rpm
- The design passes the environmental tests according to MIL- STD 331 & 810

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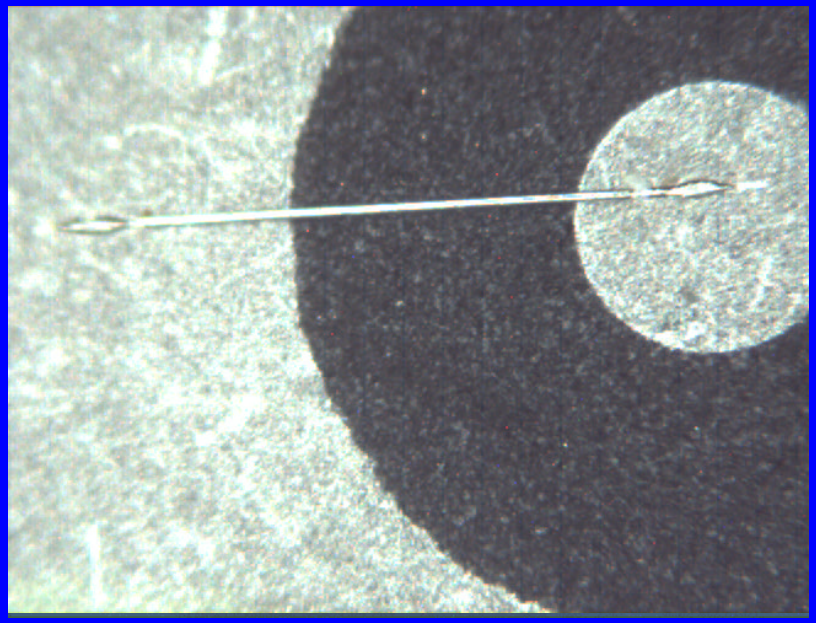
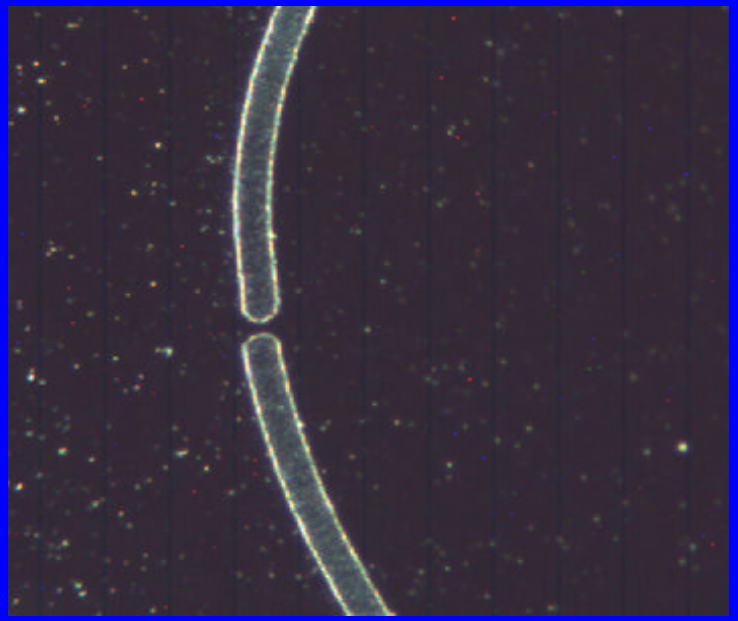
Bridge-wire vs. Thin-film

- The thin film has no welding process
- Thin film better withstands rough handling
- Thin film requires more manufacturing steps
- Thin film is less sensitive i.e. no broken bridges





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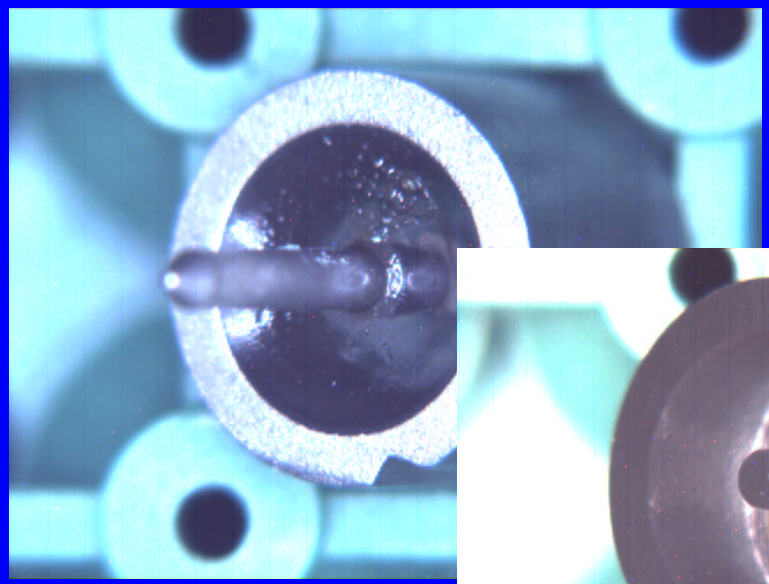
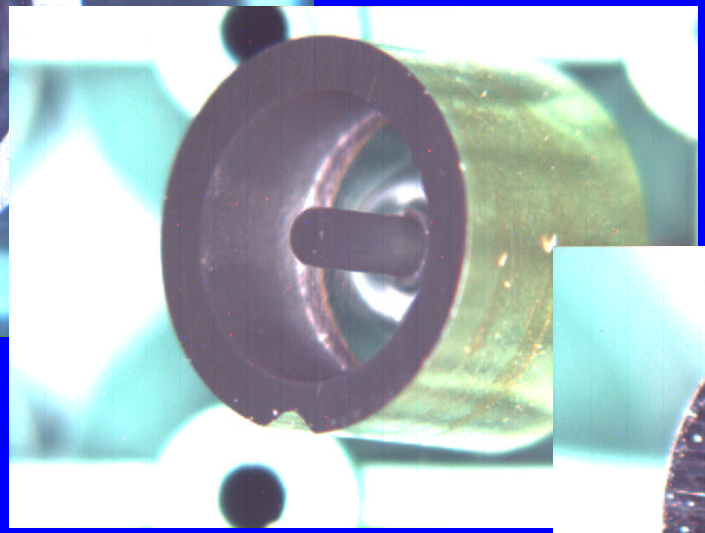
Key-Components: Detonator Pole-Piece

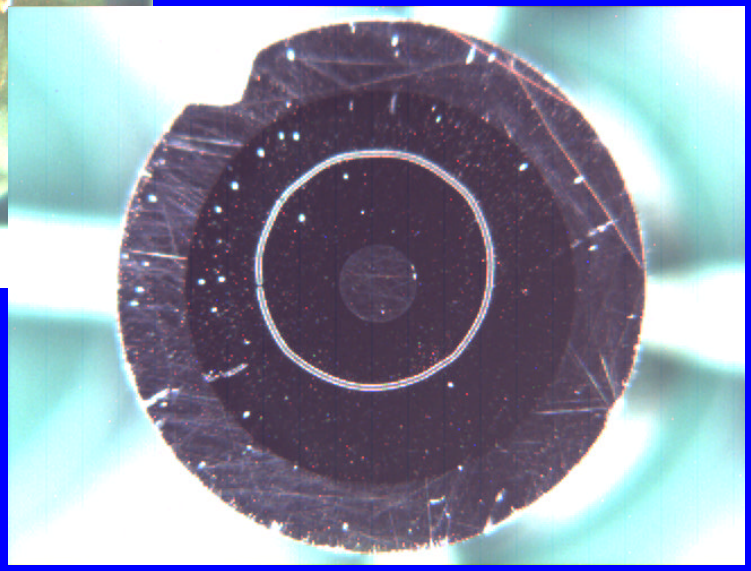


Glass to metal sealing



Polishing process

Vapor deposition



Laser cut resistance

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Key-Components: Silverazide vs. Leadazide

- AgN3 and PbN3 are about equal in friction sensitivity
- The electrostatic sensitivity of AgN3 is about 10 times less than that of PbN3
- With AgN3 is no danger for a chemical forming into Copperazide
- The relative energy output of AgN3 is higher than of PbN3
- AgN3 has very good chemical stability
- Handling of AgN3 is more sensitive than PbN3 during manufacturing

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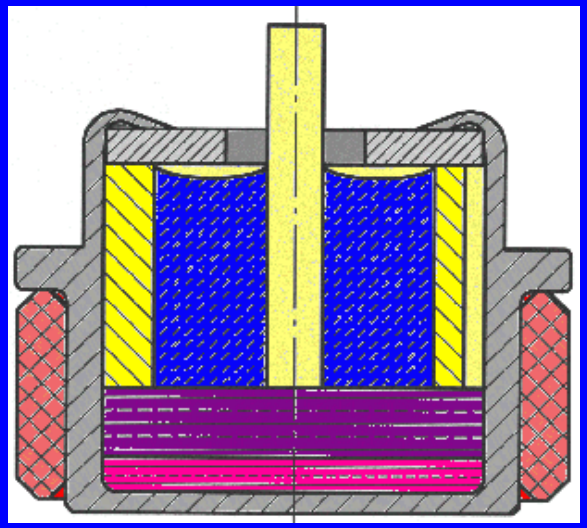
Reference Projects with thin film technology

Detonator for Mauser-Aircraft Gun (Tornado)

- Detonator withstands extremly high g loads
- Detonator withstands 105'000 rpm
- More than 400'000 pcs have been manufactured successfully



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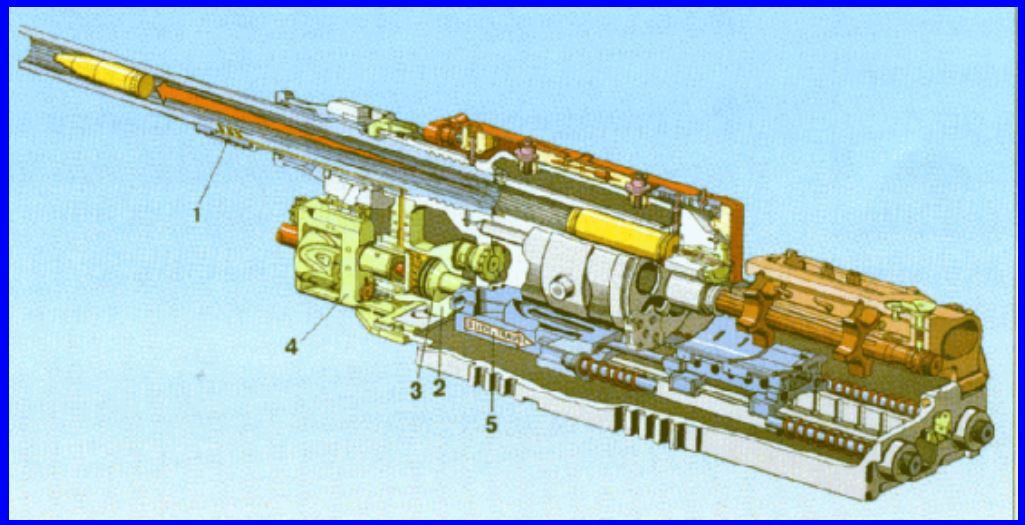
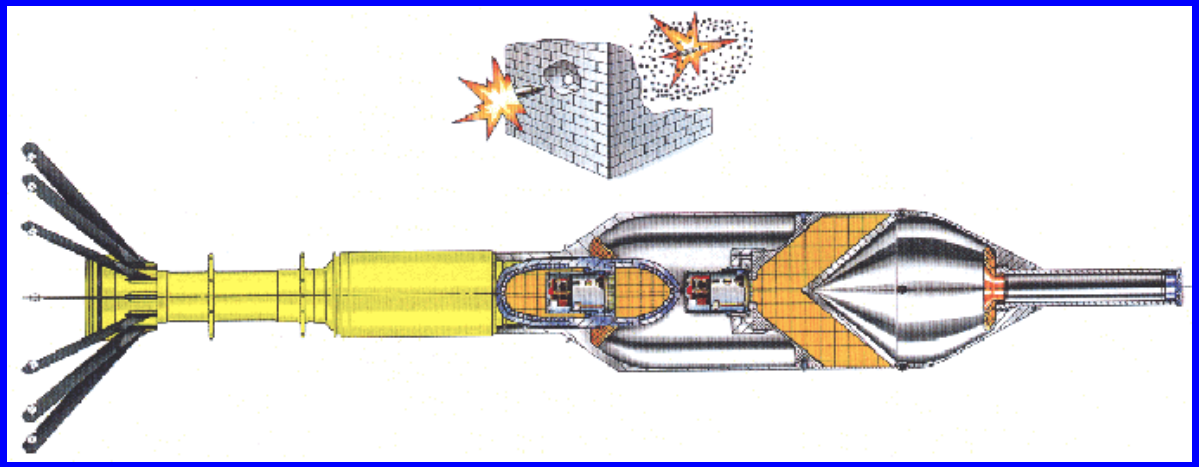


Mauser 27mm Aircraft Gun

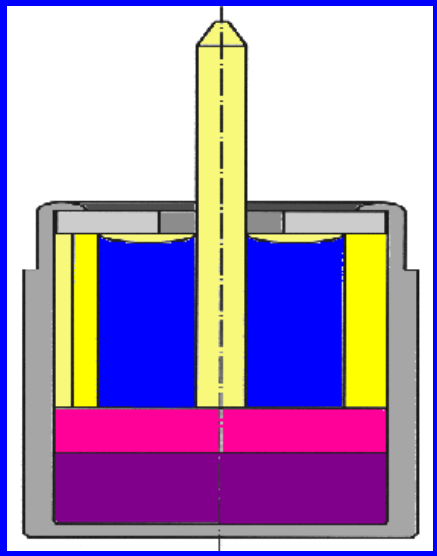
Reference Projects with thin film technology

Detonator DM1461 used in the German Bunkerfaust

- The Detonator in the follow through grenade withstands >50'000g
- More than 300'000 detonators of this type are manufactured for different projects



Bunkerfaust Dynamit Nobel / Diehl



DM1461

Future Designs for Thin film detonators

-
- Use in Ammunition with high acceleration up to 100'000g
- Use in Ammunition with high spin rates up to 120'000 rpm
- Thin film technology can be used in miniaturized Fuze systems for small warheads and future Airbag igniter designs.

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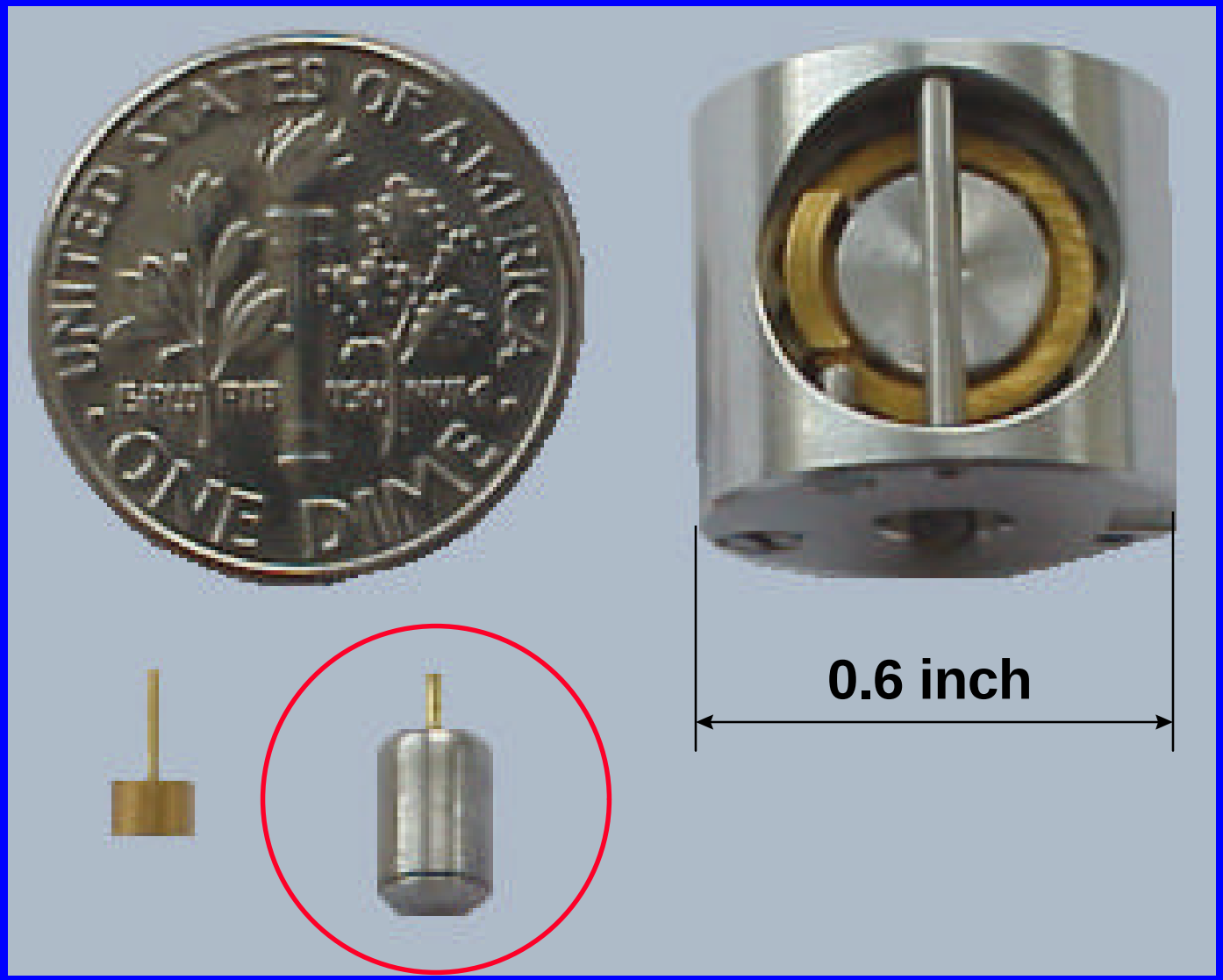

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Summary

- Thin film technology is a high quality alternative to the standard Bridge wire-technology
- For special requirements like high acceleration or high spin rates the ballistic and energy advantages of the thin film are much more than those of a bridge wire detonator
- The thin film technology is a well proven method in use for more than 15 years.

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